Title: Blast Off

Brief Overview:

With this project, the students become aerospace engineers, designing and building rockets. This motivating unit uses Balloon Rockets to collect, organize, and display data in a stem and leaf plot and scatter plots. The unit challenges students to find the range, median, and mode.

NCTM Content Standard/National Science Education Standard:

1. Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them.
2. Design investigations to address a question.
3. Consider how data presentation affects the interpretation of data.
4. Collect data using experimentation.
5. Represent data using tables and graphs such as stem and leafs and scatter plots.

Grade/Level:

4-5

Duration/Length:

4 Days, 60 minutes a day.

Student Outcomes:

Students will:

- Collect and organize data to answer questions
- Develop and interpret stem and leaf plots and scatter plots
- Apply knowledge of range, median, mode, and circumference

Materials and Resources:

Lesson 1

- Plastic bags, one for each group
  - Balloons (2)
  - Straw (1)
  - Scotch tape
  - Nylon string (40 feet)
  - Ruler
- Masking tape
- Calculators
- Index cards for Pre-assessment activity
- Student Resource 1, "How to Launch Your Balloon Rocket" (1 per group)
- Student Resource 2, "How Far Will My Balloon Travel?" (1 per student)
- Student Resource 3, "Whole Class Rocket Launch Data Sheet" (1 per student)
- Teacher Resource 1, "Pre-assessment Stem and Leaf Plot Exercise"

Lesson 2

- Set up launch area in advance, same as Day 1
- Plastic bags for balloon rocket materials (One bag per group of 4 or 5 students)
  - Balloons (2)
  - Nylon string (40 feet)
  - Straw (1)
  - Scotch tape
  - Tape measure (1)
- Transparency of Teacher Resource 2 "Scatter Plot"
- Overhead projector
- Overhead markers
- Student Resource 4, "How Does Size of Balloon Affect Rocket Distance?"
- Student Resource 5, "Class Results of Rocket Launch Data"

Lesson 3

- Set up launch area as in Day 1 in advance of class
- Plastic bags for balloon rocket materials (One bag per group of 4 or 5 students)
  - Balloons (2)
  - Nylon string (40 feet)
  - Straw (1)
  - Scotch tape
  - Tape measure (1)
  - Paper clips (10)
- Transparency of Teacher Resource 3, "Day 3 Pre-Assessment."
- Overhead projector
- Student Resource 6, "Transporting Your Cargo"
- Student Resource 7, "Brainstorm"

Summative

- Student Resource 8, "Blast Off To The Sun"

Advanced preparation:

Set up the launch area for Days 1, 2, 3 and 4. The balloons can travel around 25 feet or more so you may want to use a larger room than your classroom for your launch site. You will need one string "runway" for each student group that consists of about 4-5 students. For each group you will need a chair for students to tie off the end of about 40 feet of string. Determine the start point of the launch area. Mark the start point on the floor with masking tape. Mark off every foot and number it on the floor with masking tape from the start line to the finish area. (This ensures that the students will not have to measure each launch distance with a tape measure. Remember the purpose of the project is to collect data and find averages.)

Prepare zip lock bags for each student group with materials (See Materials for Day 1).
Prepare index cards for pre-assessment activity

Development/Procedures:

Lesson 1 – "How Far Can Your Rocket Travel?"

Pre-assessment

- Ask students how mathematicians and scientists collect data.
- Ask students what the word average means. Elicit responses that average means what is typical or what is expected. You can use the example of weather. What temperature do you expect it to be in July?
- Do a visual representation of a stem and leaf plot with your class to review and assess the concepts of range, median, and mode. See Teacher Resource 1, "Pre Assessment Stem and Leaf Plot Exercise."

Launch

- Explain that the students will work in groups as "scientists/mathematicians" to collect a set of data recording how far the balloon rockets travel along a string. As a whole class, they will interpret the data to find the average distance traveled.
- Demonstrate a Balloon Rocket to the students. Be sure to tell the student to blow up the balloon to a diameter of about 8 inches (depending on ballon type) and demonstrate how to measure it by holding a ruler up to the balloon.

Teacher Facilitation

- Explain to students that the assignment is to work in groups to launch rockets to collect data.
- Explain to students that the floor is already marked off for each foot. They will note the closest foot to where the rocket stops.
- Explain that they will first run some practice launches.
- Then each group will run one launch for each person in the group, recording the distance traveled on Student Resource 2, "How Far Will My Balloon Rocket Travel?"
- The class will then share the data and construct a class stem and leaf plot.
- By analyzing the class data, the range, median, and mode are noted.
- Distribute materials assembled in bags along with Student Resource 1, "How to Launch Your Balloon Rocket," (one for each group).

Student Application

- Students will check bags to see that all materials are enclosed.
- Students will estimate how far their rocket will travel on Student Resource 2, "How Far Will My Balloon Rocket Travel?"
- Students will discuss in small groups how they will work together cooperatively to build and launch rockets.
- Proceed to launch area.
- Students will practice a few launches, measuring the distance for each one.
- Students will begin data collection.
- Students will share data with the class and construct a class stem and leaf plot.
- Students will note any outliers, and identify the range, median and mode on Student Resource 3, "Whole Class Rocket Launch Data Sheet."
- Students think and write critically to answer the last two questions on Student Resource 3, "Whole Class Rocket Launch Data Sheet."

Embedded Assessment

- Informally evaluate classroom participation during the stem and leaf plot exercise following the collection of data.
- Ask probing questions such as these sample questions: "*How many samples of data do we have? Can you organize the numbers in order from least to greatest? Are there any outliers? Why or why not? What is an outlier? What number, (distance) occurs the most frequently? What is the mode? How do you find the median? What is the median? "*
- Teacher reads over each student's written responses on Student Resource 3, "Whole Class Rocket Launch Data Sheet."

Reteaching/Extension

- If a student doesn't understand the concepts of range, median and mode, work with them individually or in a small group to re-teach. Use the index cards from the pre-assessment activity to help students to organize the data to find the range, median, or mode. You can also use connecting cubes to represent the numbers, one cube for each number.
- As an extension activity students could use calculators to determine the mean.

Lesson 2 – "Does Size Matter"

Pre-assessment

Ask questions to promote thinking and discussion for students and to determine if they know about circumference and variables:

- *What is circumference?* Invite a student to draw a circle on the overhead. Ask student to identify the circumference of that circle.
- *What is the best way to measure the circumference of a round object?* (Demonstrate how to measure a sphere with a tape measure.)
- *What is a variable?* (A variable is a change in a quality or value) *"What are some ways you could change a variable in the balloon rocket launch?"*
- *What do you think would happen if the balloons were different sizes? What experiences have you had that would make you think that?* (If you blow on something it can move. If you blow harder it blows farther.)
- *What is a good way to display those results in a graph?*
- Instruct students that they will graph their groups' data on a bar graph and learn about scatter plots.
- Students will analyze a scatter plot as a class on the overhead projector and interpret that graph (Teacher Resource 2.) NOTE: This just has to be touched upon since it is not a specifically known skill.

Launch

- Tell students they will make a hypothesis about how the size of a balloon will affect the distance the rocket travels.
- Invite two student volunteers to come up to the front. One volunteer blows up a balloon and the other one measures the circumference
- Tell them each group will blast off 5 balloon rockets with balloons measuring different circumferences, 10 in., 15 in., 20 in., 25 in., and 30 in.
- Students will record data for each launch on Students Resource 4, "How Does Size Of Balloon Affect Rocket Distance?"
- Students will graph results on a bar graph within science groups.

Teacher Facilitation

- Set up launch area as for Day 1.
- Assemble bags for each student group with materials (See materials for Day 2).
- Distribute rocket packets.
- Distribute Student Resource 4 (2 pages).
- Using data collected during launches, model the construction of a scatter plot on an overhead projector to introduce students to scatter plots. Provide graph paper and allow students to make their own as an extension activity.
- Interpret and analyze the scatter plot to determine if there is a correlation between the circumference of the balloon and the distance the rocket travels.
- What conclusions can be made? Does balloon size appear to have an effect on launch distance?

- Is there a relationship between the size of the balloon circumference and the distance the rocket traveled?
- Was their hypothesis correct?
- Why was it necessary to look at all of the data from the class to make this assumption? (Looking at one piece of data is not enough.)
- Therefore, the scatter plot was helpful in determining a possible correlation between the circumference of the balloon and the distance it traveled. Bar graphs are useful in comparing data.

Student Application

- Prepare to blast off!
- Each group checks that it has materials for launch (see Materials for Day 2).
- Students will make a hypothesis and write it on Student Resource 4, "How Does Balloon Size Affect Rocket Distance?"
- Students conduct experiments in small groups, changing the diameter of the balloon.
- Each group will launch and record data for each balloon circumference on Student Resource 4, "How Does Balloon Size Affect Rocket Distance?"
- Each group will create a bar graph displaying their data on Student Resource 4, "How Does Balloon Size Affect Rocket Distance?"
- Students will work with the class data to create and interpret a scatter plot.
- Students will compare the scatter plot and bar graph to conclude that it is better to have more than one piece of data in order to form conclusions.

Embedded Assessment

- Observe students recording launch data. Make incidental notes on individual student contributions to the creation of a bar graph.
- Look at students' finished bar graph to see if it is labeled and if they can interpret and analyze the data.
- Evaluate student responses while making the scatter plot on the overhead projector. Have students analyze the data.

Reteaching

- If students are unable to create a bar graph, provide data from another group and ask them to try again with teacher assistance and prompts.
- Allow students to discuss what the graph suggests about the data.

Extension

- Distribute Student Resource 5, "Class Results of Launch Data", as an extension activity for students who would like to take on the challenge of graphing all of the class data in a scatter plot.

- Provide an opportunity for critical thinking by asking them to draw conclusions and make associations by interpreting the scatter plot graph.

Lesson 3 – "Adding Cargo".....

Pre-assessment

- Students answer journal question from overhead, Teacher Resource 3, "Day 3 Pre-Assessment." Students have approximately 10 minutes to respond in their journals.

Launch

- After students have had an opportunity to complete the pre-assessment journal entry, ask volunteers to share their answers. Encourage discussion about responses.

Teacher Facilitation

- Explain to students, "As a team of aerospace engineers you now need to consider the effects of cargo on your rocket's distance. For this simulation you will add paperclips to your balloon rocket to simulate cargo." NOTE: Tape paperclips with tape then the rest hooks on.
- Distribute a copy of Student Resource 6, "Transporting Your Cargo" to each student.
- Ask, "*Do you think you will notice much of a difference when you add each paper clip to your rocket*? *What amount of paper clips do you think will begin to have the most effect on your rockets' distances?*"
- Explain that they will record results of their rockets distances with increasing cargo, for each launch on Student Resource 6, "Transporting Your Cargo."

Student Application

- Proceed to launch area.
- Students will prepare rocket with cargo; 2 clips, 4 clips, 6 clips, 8 clips, and finally 10 clips.
- Have students' record distance of each rocket launch with increasing cargo amounts.
- Students will transfer their data to the front board with the rest of the class data.
- Instruct students to make a scatter plot of the class cargo data.
- After the students complete the scatter plot, challenge them to make conclusions about the effect of cargo on the balloon rocket.

- Students will write a follow up to their original cargo hypothesis, using the data as support for their responses.

Embedded Assessment

- Students will demonstrate their knowledge of collecting and reading data by constructing a scatter plot correctly.
- Students will demonstrate their knowledge of analyzing and understanding data by revising their original journal answer and using their graph conclusions as support.

Extension

- Students brainstorm as a team another variable, other than cargo or balloon circumference, which would affect or improve the distance of their rocket travels. See Student Resource 7, "Brainstorm."
- Student groups determine how they could simulate this variable for testing.
- Students determine the type of graph that would best display the data they collected.

Summative Assessment

"Blast off to the Sun"

Students will consider all of the data collected over the three days of testing. Each student group will design a launch where the rocket will stop at a target, the sun.
First, a detailed drawing will be made of the balloon rocket complete with or without cargo on Student Resource 8, "Blast Off To The Sun." The student must label the balloon with the measurement of its circumference. Each student must then explain why he or she has chosen that type of design. The explanation must state what data was important in making the decision that they made.

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PRE- ASSESSMENT STEM AND LEAF PLOT EXERCISE

- Explain you have sample "data" collected by "mathematicians."

- Write the following "data" on the board.
  8, 4, 29, 8, 5, 7, 8, 13, 11, 5
- Have students organize the numbers in numerical order.

- Create a stem and leaf plot of the numbers.

- Ask class: *Are there any outliers? (Yes, 29)*

- Say: *What is the range?* (25)
  (Explanation: The lowest number is 4 and the highest is 29 and subtracting those numbers gives you 25 as the range.)

- Say: *What is the mode?* (8)

- *Say: What is the median*? (8)

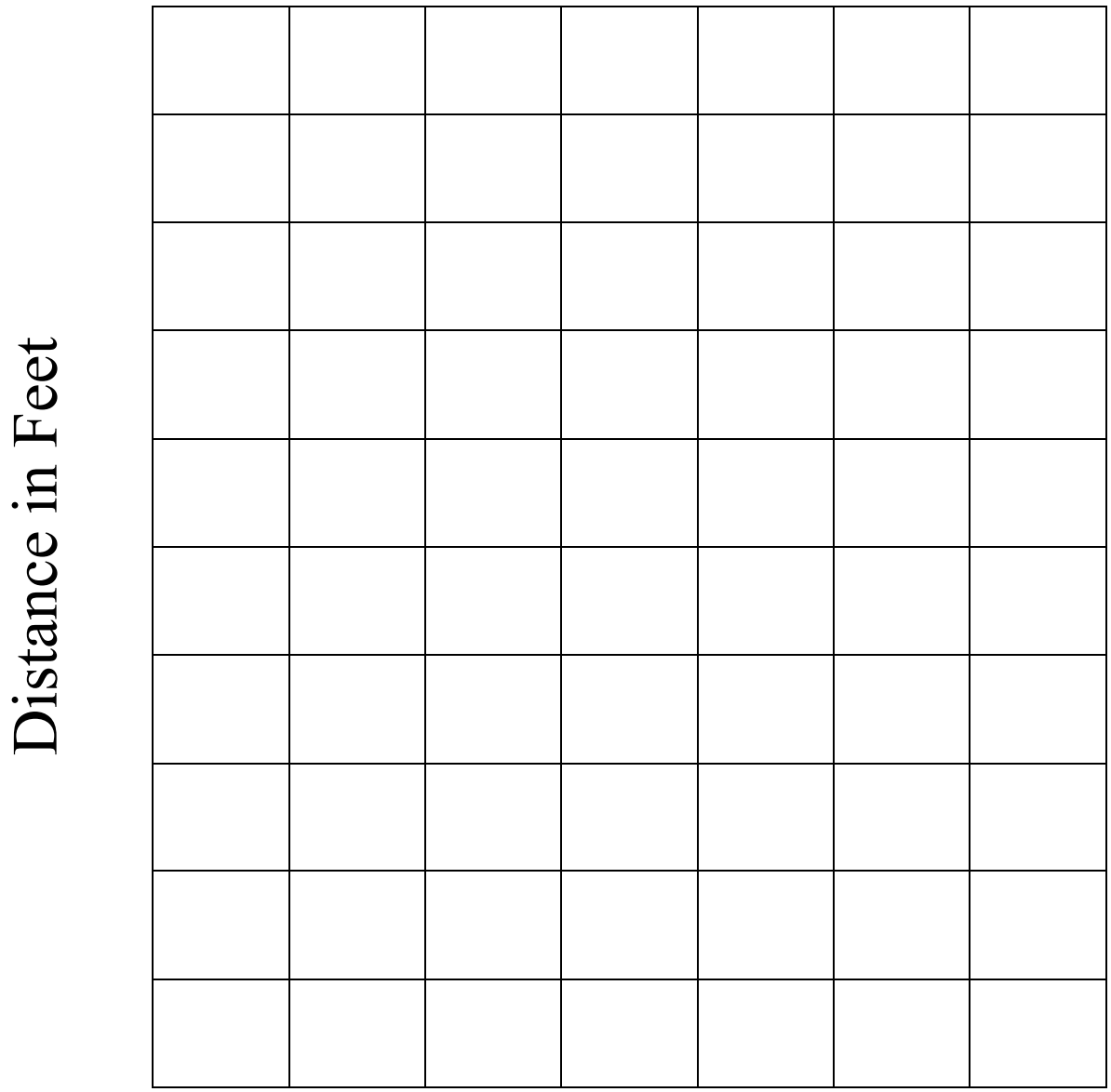
(extension)

- *Say*: Does anyone know how to find the mean? (Almost 10)

Teacher Resource 2

Scatter Plot Transparency

_____



Day 3 Pre-Assessment

- **What type of cargo would rockets carry on their missions into space?**
- **What limitations do you think they would have?**
- **What effect do you think adding cargo to your team's rocket will have on its travels?**
- **How could you simulate cargo on your rocket?**

HOW TO LAUNCH YOUR BALLOON ROCKET

Step A: Make sure you have all of your materials

WHAT YOU NEED

1 Balloon
1 Drinking Straw
1 Clothespin
40 feet of nylon string
Scotch tape
Ruler to measure balloon diameter

Step B: Directions

HOW TO LAUNCH YOUR BALLOON ROCKET

1. Tie one end of the string to a chair in the launch area while another group member holds the other end so that the string is tight.
2. Thread the string through the drinking straw.
3. Inflate the balloon to a diameter of about 5 inches, but do not tie it, use the clothespin to clamp it shut or hold it tight.
4. Tape the balloon along the length of the straw
5. Line up the balloon rocket with the start line.
6. Release balloon rocket, blast off!!
7. Practice a few times making sure your rocket operates correctly.
8. Begin your experiment taking turns launching one rocket for each person measuring the distanced to the nearest foot.
9. Measure the distance traveled to the nearest foot.
10. FOR THIS TO BE SUCCESSFUL YOU MUST WORK TOGETHER AS A GROUP.

NAME_____ **DATE**_____

HOW FAR WILL MY BALLOON ROCKET TRAVEL?

After looking at the demonstration of a balloon rocket launch, record your estimation in feet of the distance you think your rocket will travel to the nearest foot.

1. I THINK MY ROCKET WILL TRAVEL_____Feet.

2. RECORD THE DATA FOR YOUR GROUP'S LAUNCHES

Launch 1	**Feet**
Launch 2	**Feet**
Launch 3	**Feet**
Launch 4	**Feet**
Launch 5	**Feet**

3. What was the greatest distance a rocket traveled in your group?

4. What was the least distance a rocket traveled in your group?

5. Did you have any problems with your rocket launches?

Name_____ Date_____

WHOLE CLASS ROCKET LAUNCH DATA SHEET

Were there any outliers and what were they? _____

What is the farthest distance? _____ Feet

What is the least distance? _____ Feet

What is the RANGE? _____ Feet

To find the RANGE subtract the least distance from the farthest distance. Set up your subtraction problem and place your answer on the lines above.

What is the MODE? _____
To find the MODE look for the measurement that occurs the most often.

What is the MEDIAN? _____
The measurement that lies in the middle after the data is put in order from least to greatest is the MEDIAN.

How did your original estimate compare with the actual distance your rocket traveled?

Explain how finding the range, mode, and median will help you estimate how far your balloon rocket will travel on your next launch.

_____

_____

Student Resource 4

Name_____ Date_____

HOW DOES SIZE OF BALLOON AFFECT ROCKET DISTANCE?

My hypothesis is that the _____ the balloon the

_____ the distance.

MY GROUP'S CHART OF ROCKET LAUNCH DATA

Balloon circumference 10 inches	Distance Feet
Balloon circumference 15 inches	Distance Feet
Balloon circumference 20 inches	Distance Feet
Balloon circumference 25 inches	Distance Feet
Balloon circumference 30 inches	Distance Feet

Bar Graph Worksheet

_____ **(Name)** _____ **(date)**

_____ **(Title)**

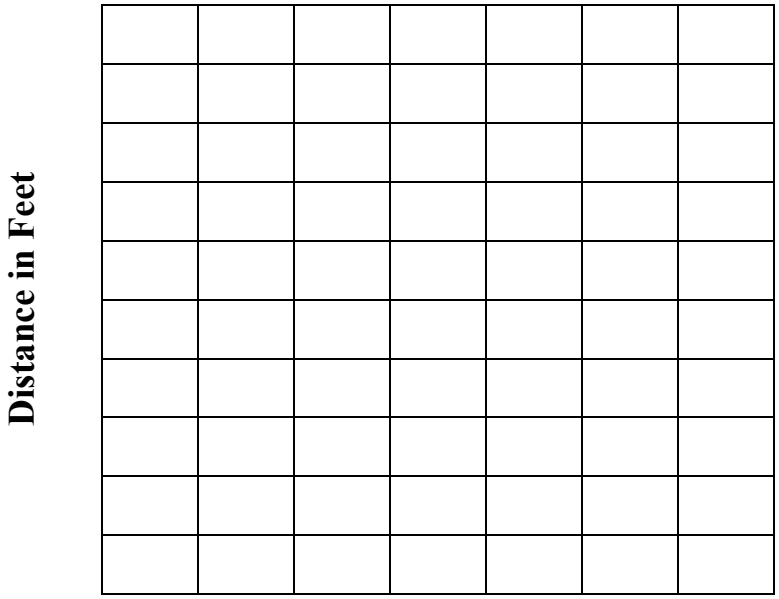
Extension

Name_____ Date _____

CLASS RESULTS OF ROCKET LAUNCH DATA

Balloon Circumference	Distance in feet
10 in.	
15 in.	
20 in.	
25 in.	
30 in.	

The Effects of Circumference on Distance



What conclusion can you make from the scatter plot?

_____

_____

_____

Transporting Your Cargo

My hypothesis is that with each paper clip added our balloon rocket will_____,because_____

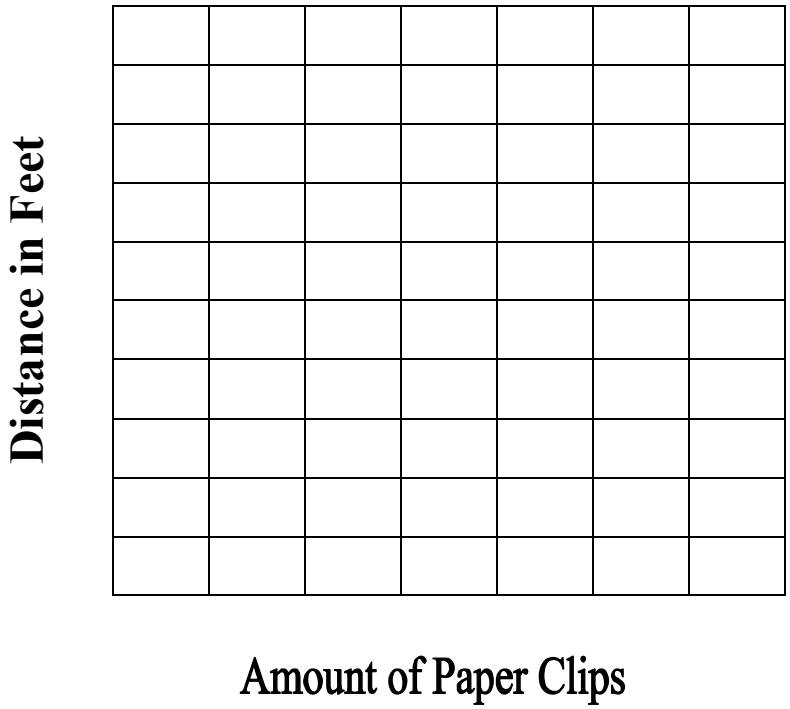
_____.

_____ amount of paper clips that will have the most effect on our rocket's

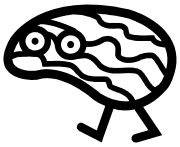
distance, because_____.

Cargo (Paper Clips)	Distance (Feet)
2	
4	
6	
8	
10	

The Effects of Cargo on Balloon Rockets Distance



Extension



BRAINSTORM

As a team brainstorm other variables, other than cargo or balloon circumference that could affect the distance that your balloon rocket travels.

_____

_____

_____

_____

Choose one of those variables and determine how you could simulate this variable's effect on your balloon rocket's traveled distance.

_____

_____

_____

_____

What type of graph would best display the results of the data you would collect? Explain why you choose that type of graph.

_____

_____

_____

_____

Student Resource 8

Name _____ Date_____

BLAST OFF TO THE SUN

1. Work in your small science groups to plan and design a rocket launch that will end at the target of the sun. The target will be placed 21 feet from the start line. Look over past launch data and graphs of data to help you make a plan that shows you understand how to interpret the data.

2 Make a detailed drawing of the balloon rocket you plan to launch. Include drawings of any cargo and how much cargo you would add. Be sure to draw the balloon inflated and labeled with its.

3 Explain in three sentences why you selected this design.

WORD BANK: **data, analysis, average, mean, median, mode, scatter plot**

My actual launch went ____ feet. It was ____feet from the sun.